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Manual Transmission Efficiency and Parasitic Loss Measurement

RATIONALE

Document is current and appears unlikely to be in need of revision in the foreseeable future.

STABILIZED NOTICE

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1. ***Scope***—Because of the intense focus on fuel economy and fuel emission standards, it has become imperative to optimize vehicle drivetrains. In light of this, component efficiencies have become an important factor in the drivetrain decision-making process. It has therefore become necessary to develop a universal standard to judge transmission efficiency.

This SAE Recommended Practice specifies a test procedure which maps torque transmittal efficiency and parasitic losses for manual transmissions. The application of this document is intended for manual transmissions used in light (class 4) through heavy truck applications with both simple and compound ratio structures.

This document is separated into two parts. The first compares input and output torque throughout a specified input speed range in order to determine the overall transmission efficiency. This test is used to evaluate all forward gears; testing in reverse is optional. The second procedure measures parasitic losses experienced at zero output torque over a range of operating speeds. A procedure for further reduction of this data into a loaded efficiency from gear and bearing systems is also provided.

2. ***References***

2.1 Related Publication—The following publication is provided for information purposes only and is not a required part of this document.

SAE Paper 840054—Measurements of Power Losses in Automotive Drive Train

3. ***Definitions***

3.1 Manual Transmission—The assembly exclusive of the clutch which is driven by the engine and used, through manual interface, to effect a ratio change in transmitting power to the final drive system.

4. Equipment

4.1 Test Cell—Efficiency tests require a prime mover and absorption unit with torque and speed capability beyond that required for test data points. Motors with either hydraulic or electric drives are ideal for this type of test due to their relatively precise torque and speed control although diesel dynamometers may be used if necessary. The recommended procedure for this test is unique compared to more conventional load/speed tests in that it requires two transmissions, mounted output shaft end to output shaft end in order to isolate true system losses. This requirement may be satisfied by either a Four Square type test cell or Dynamometer whose bed plate length will accept the length of the back to back units between the drive unit and absorber. Either cell type must be supplemented by the following mounting and measurement hardware; Figure 1 provides a simplified diagram of the test setup:

a. Trunnion Bearing Mounts—Both test transmissions must be supported at their input and output shafts by a trunnion type bearing mount. This will permit the installed transmission(s) to rotate freely about their axis.
b. Torque Reaction Arm—A torque reaction arm is installed between the drive and coast transmission cases. An additional moment arm is mounted to, and extends out from the drive unit's case on a horizontal plane and then attached to a calibrated load cell at a known length from the mainshaft centerline. This load cell is in turn mounted to ground to permit measurement of the linear force component of the combined torque losses from each unit. Transmission losses are converted into a torque moment by calculating the product of the reaction arm length and the load cell reading and then dividing by two to reflect the average loss per unit.
c. Mounting Orientation—The cell must be capable of mounting the transmissions at the production intent inclination and roll angles. It is also desirable to test at zero degrees inclination for comparison to competitive test data.
d. Torque Measurement—Proper load cell selection is critical for test accuracy. A precision linear load cell transducer is required accurate to within 0.25% of full scale. This potential error is acceptable if the unit's full-scale reading is closely matched to the peak expected measured value. A Torque Transducer is used at the input side of the drive unit. This transducer should also be selected to minimize measurement error by selection of a cell with minimal error (<1% of full scale recommended) and again matching its maximum value to desired test points. Steps should be taken on both torque and linear load measurement systems to minimize or eliminate any additional accuracy losses due to signal conditioning, filtering, etc.
e. Speed Control—The cell must be capable of maintaining speed within ±5 RPM of the specified speed throughout the test torque range.
f. Temperature Controls—Supplemental sump lubricant cooling or heating may be required to maintain sump temperatures of 82 °C ± 2 °C.
g. Calibration—Calibration curves should be performed for all equipment and instrumentation after every test ratio to assure data accuracy.

5. Test Procedure

5.1 Preparation and Set-Up—Ideally, the test transmission should be randomly selected from normal production. When a test unit must be built specifically for efficiency testing, any design features (surface finishes, selective fits, coatings, etc.) which may effect efficiency should be representative of production intent and set as close to nominal conditions as possible. Inclusion of any optional accessories (PTO, pumps, brakes, etc.) which may effect test results is the decision of the tester but should be noted in test documentation. It is recommended that the base version be tested in all cases to permit future comparisons and determine accessory impact on results.